the name is a synonym of *Aecidium Oxalidis* Thuem., judging from the brief description in Saccardo's Syll. **11**:215, and from the fact that corn is grown in the region where the fungus was found.

1893. Collected on *Oxalis stricta* L. at Lincoln, Neb., by the Botanical Seminar (Bot. Survey Neb. **3**:10). I have not seen the collection.

1894, 1899. The herbarium of the writer also contains a collection made by Mr. T. A. Williams on July 13, 1894, at Brookings, S. D. and one by Mr. E. Bartholomew on June 5, 1899, in Rooks county, Kan., both on *Oxalis stricta* L., of which there is no published record.

Summing up the evidence, the writer believes that all the above collections can be placed with much confidence under *Puccinia Sorghi* Schw., as representing the aecidial stage of the fungus. It would be interesting to discuss the change in views which this discovery of the aecidium must produce regarding the propagation and dissemination of corn rust, but that can better be left for another occasion.—J. C. ARTHUR, *Purdue University, Lafayette, Ind.*

AN EXPERIMENT ON THE RELATION OF SOIL PHYSICS TO PLANT GROWTH.

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY. LX.

(WITH THREE FIGURES)

IN studies of the relation of soils to vegetational distribution in Michigan,[1] one of the authors found reason to believe that the nature of the vegetation covering any upland area of that region has been determined by the amount of water present in the surface layers of the soil. Furthermore, it was pointed out that, with the exception of swamp margins, the amount of water thus present is dependent upon the physical nature of the soil, especially upon its water-retaining or capillary power, which, in turn, is largely dependent upon the size of the soil particles. The physics of this proposition, together with the literature thereon, is discussed in a paper about to appear in the Annual Report of the Michigan Board of Geological Survey for 1903. It will be necessary to state here only the general fact that the smaller the particles of a soil, the greater will be its water-retaining power, and the larger the particles, the smaller this property. Also, the greater the retaining power, the greater will be the power to lift water from a lower level. Thus, clay soils have a great power of

[1] LIVINGSTON, B. E., The distribution of the plant societies of Kent county, Michigan. Ann. Report Michigan Board of Geol. Survey, 1901.

The distribution of the upland plant societies of Kent county, Michigan. BOT. GAZ. **35**:36–55. 1903.

retaining and lifting water, while sandy soils possess this property to a much less degree.

Since the natural soils dealt with in the paper cited differ chemically as well as physically, clay being largely composed of alumina and sand of silica, it seemed wise actually to test by field cultures the hypothesis above referred to. It was desirable that in these cultures the several soils should at the start be chemically the same, while their physical properties alone

FIG. 1.

should differ. To this end crushed quartz, containing 99.8 per cent. pure silica, was obtained in three sizes or grades. The particles of the finest grade have an average diameter of 0.02^{mm}; those of the medium 0.6^{mm}; and those of the coarse 1.15^{mm}. To these different sands were added mineral salts which should supply the essentials for plant growth. The proportion of the ions to the volume of soil was made approximately the same as it was found to be in natural fertile soils by Taylor and Mooney.[2] The salts actually used were KH_2PO_4, $Ca(NO_3)_2$, $MgSO_4$, $NaNO_3$ and $CaCl_2$. All three grades of sand were treated exactly alike.

Three ordinary apple barrels were chosen for the cultures. These

[2] U. S. Dept. of Agric., Bureau of Soils, Bull. 22:37. 1903.

have an end diameter of 40^{cm} and a height of 70^{cm}. After a number of holes had been bored in the sides and bottom, each of these was placed upright, with the top even with the general ground surface, in gravelly sand of an ancient lake beach in the experiment grounds of this laboratory. The barrels stand in a north-and-south row about a meter apart, the finest soil being at the southern end of the row, the coarsest at the northern. Each barrel was filled to the brim with its particular grade of culture soil, the salts being added in solution as the sand was shoveled in. The soil in and around the barrels was then thoroughly soaked with water. After the

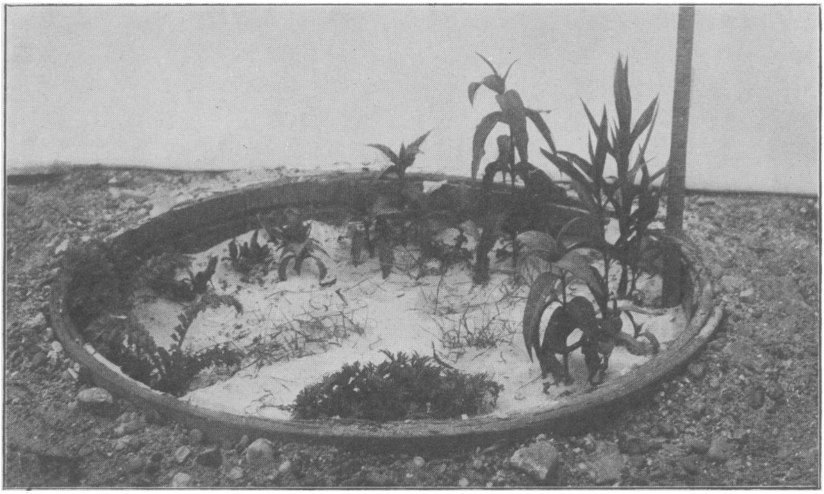

FIG. 2.

soils thus prepared had stood several days, wild plants were dug in the vicinity of the university and set out in the cultures, practically all of the soil adhering to their roots having first been removed by gentle water-washing.

Similar plants, from the same locality, and often from the same clump, were chosen for the cultures. Immediately following the planting, sufficient water to wash the soil closely around the roots was added and no subsequent watering was done. The plants used are as follows: *Poa compressa*, *Poa pratensis*, *Potentilla anserina*, *Potentilla argentea*, *Solidago serotina*, *Helianthus strumosus*, *Helianthus divaricatus*, *Verbena stricta*, and *Verbena hastata*.

Placed in the open, as the cultures are, they have been subjected to the same external moisture conditions both in regard to precipitation and

absorption from the surrounding natural soil. At the time of placing the barrels, the ground water of the ridge where they were sunk had its surface at a depth of 2.2^m, *i. e.*, 1.5^m below the bottom of the barrels. Thus the three cultures present no differences either in external water or in chemical nature, but differ only in size of their component quartz particles. It need hardly be added that the gravelly sand surrounding the barrels is perfectly uniform throughout the series.

FIG. 3.

The cultures were started May 5, 1904. For the first few days no difference was to be noted in the growth of the plants, but gradually those in the finest sand forged ahead of the others, and on June 5 a difference was very well marked. The plants in the finest material showed a much greater growth and a greater general thriftiness of vegetation The photographs here presented exhibit clearly the relation between the three cultures as they existed on June 15. *Fig. 1* shows the condition of the culture in fine sand; *fig. 2*, that in medium sand; and *fig. 3*, that in coarse sand.

The following table shows the height in centimeters of the plants in the three cultures on June 15.

Plant	Fine soil	Medium soil	Coarse soil
Potentilla anserina	20–23	8–10	6– 8 (3 out of 4 dead)
Potentilla argentea	20–23	4– 5	3– 6
Verbena stricta	8–15	2– 5	2– 4
Verbena hastata	14–19	5– 8	2– 3
Solidago serotina	42–45	10–17	10–12
Helianthus strumosus	18–23	3–12	10–11
Helianthus divaricatus	22–28	14–19	10–17
Poa pratensis	15–20	dead	dead
Poa compressa	28–40	nearly dead	dead

While the above table is strikingly significant in showing relative size, and therefore relative rate of growth, it does not express at all the equally prominent features of comparative size and numbers of leaves, the presence or absence of runners, the wealth or scarcity of flowers, and all the features which go to make one plant vigorous and the other barely existing.

It will be realized at once that the experiment here described offers somewhat conclusive evidence in favor of the above-mentioned hypothesis of one of the present authors (*loc. cit.*), as well as of that recently expressed by Whitney and Cameron[3] in regard to agricultural plants. A fuller discussion and analysis of the conditions here dealt with would be out of place in this announcement, the purpose of the latter being only to state the facts in regard to the experiment. Further work along these lines is in progress.—BURTON EDWARD LIVINGSTON and GERHARD H. JENSEN, *The University of Chicago.*

A NEW GILIA.

Gilia sapphirina, sp. nov. (HUGELIA).—Erect, paniculately branched from the base, the branches slender, sparsely leaved, the main stem and some of the principal branches inclined to be tortuous, viscid-glandular throughout, 30^{cm} high or more: leaves (all but the uppermost) simple, subterete, tipped with a white bristle, often purplish, 1–5^{cm} long; uppermost leaves with two very short bristle-tipped divisions at base: flowers solitary or capitate in few-flowered clusters from most of the leaf axils, even those near the base of the stem, either sessile or on peduncles 10–15^{mm} long; involucral bracts broadly ovate and simple or 3-lobed, membranous on each side of the broad green rib, glandular and clothed with very few woolly hairs calyx 8^{mm} long, the divisions one-third the entire length, the central green rib 0.75^{mm} wide, slightly narrower than the membranous

3 WHITNEY, M., and CAMERON, F. K., The chemistry of the soil as related to crop production. U. S. Dept. of Agric., Bureau of Soils, Bull. 22:72. 1903.